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# Electronics -- A Challenge to auditors

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What effect will electronic data processing have upon auditing procedures? Will some of our customary documents and records disappear? Should audit techniques include verification of machine programs? Will internal control be strengthened or weakened by the transition to electronics? In general, how much do we really have to know about electronic data processing to do an effective job of auditing?

Answers to these and related questions are of concern to all auditors, internal or independent. The answers, of course, will be developed gradually as electronic installations become more prevalent. However, experience to date in auditing the new systems, although limited, provides clues to some of the ultimate answers.

## INTERNAL CONTROL

Our consideration of the impact of electronic data processing will begin with a discussion of some of the broader aspects of internal control.

Proper evaluation of internal control is a mandatory prerequisite to the issuance of an unqualified certificate by an independent public accountant. Similarly, internal control is uppermost in the mind of the internal auditor as he assists management in achieving efficient administration. Auditors, professional and corporate alike, are concerned with the effect that electronic data processing will have on established systems of internal control.

A fundamental characteristic of a good system of internal control is an appropriate segregation of functional responsibiliites and duties. On the other hand, maximum utilization of the expensive electronic data-processing machines requires, in many instances, a so-called "consolidated functions" approach to processing. Thus, an electronic version of the "segregation versus integration" issue is at hand.

To illustrate, in processing a sales order, the electronic equipment might be programmed to determine the availability of stock, check the customer's credit status, prepare necessary shipping documents,

adjust the inventory records, issue a purchase order to replenish the stock if the new on-hand balance is below the reorder level, prepare the sales invoice, charge the customer's account, post the accounting distribution of the sale, and accumulate desired sales statistics. All of this would be done as one processing cycle through one or more passes of the transaction through the electronic machines. Two questions arise under such a "consolidated functions" approach: (1) Is internal control weakened by consolidating responsibilities previously assigned to independent departments? (2) Will personnel in the data-processing center have sufficient over-all knowledge of accounting requirements to effect an irregularity?

Departmental segregation for internal-control purposes means that no operating department and no asset-custodian department should control its own accounting records. Thus, the basic functions of authorizing a transaction, recording the transaction, and maintaining custody of resultant assets should be separated. It appears that the several activities of the accounting department can be consolidated under electronic processing without disturbing this separation of departmental responsibilities. However, EDP, as electronic data processing is often called, will very likely take over some of the paperwork activities of the operating and custodian departments. So long as the activities mechanized relate to accounting or record-keeping, it again appears that the consolidation should not weaken control.

The internal auditor is the logical person to determine that cross-checks between departments are maintained under EDP. Data processing may be centralized, but authorization and stewardship should remain independent of data processing.

As an example, assume that a credit manager whose records are maintained on magnetic tape approves an increase in the credit limits of a particular customer. He could, of course, advise the machine operator of his intentions and the desired change could be made by direct keyboard modification of the master records. Obviously, this would provide no record of the authority for the change. The internal auditor should insist that such changes be authorized in writing. For example, the authorization could be recorded on a punched card. After processing, the approved card would be retained in the credit department files. Similar requirement should be provided for processing changes in other master records that require file maintenance of this type.

Will personnel in the data-processing center have sufficient over-all knowledge of accounting requirements to effect an irregularity? Obviously, any person who programs a complete application will have such knowledge. But the principle of segregation can be applied to the duties of employees within the data-processing center. Programming, broadly speaking, comprises system design, block diagramming, coding of machine instructions, and testing. These activities can be segregated.

Installation of electronic equipment may increase the likelihood of collusion among employees to defraud the organization. There will be fewer employees involved in data processing; accordingly, fewer people need be involved in the scheme.

How would an EDP operator, familiar with the over-all programming of an application, perpetrate an irregularity, either through collusion or through some weakness in control? Here are four possible methods: (1) manipulation of input media; (2) manipulation of externally stored program; (3) keyboard alteration of data stored in memory; and (4) keyboard modification of internally stored programs.

Input media, such as punched cards or paper tape, could, in the absence of effective controls, be altered by the machine operator. In a file-maintenance type of application, he could alter either the transaction media or the media containing permanent or master records. For example, in a payroll application, he could increase the number of hours worked for a given employee or he could increase the rate of pay contained in the master personnel file.

Machine instruction programs are usually stored on punched cards or on magnetic tape. If the programs are altered by the operator, the machine will become a reliable accomplice to his scheme. Similarly, transactions, master data, and instructions can be modified by the operator during the processing of data by depressing appropriate keys on the control console. There will be no tell-tale erasure marks to trace alterations such as these.

Such practices must be based upon some weakness in control if they are to be profitable to the operator. The auditor's responsibility is to determine that such weaknesses do not exist. To fulfill this responsibility he must have an adequate knowledge of control techniques, both mechanical and human.

Let us consider these control techniques and related auditing

procedures under the following classifications: (1) input; (2) processing; and (3) output.

## INPUT

### Authenticity of Source Data

In most electronic installations, source documents, such as time cards, vendor invoices, receiving reports, and material requisitions, will continue to serve as the raw material for the data-processing operations. The validity of resultant transactions will continue to be established by the auditor by customary procedures, since approvals and other evidence of regularity will be available in visible form.

However, an auditing problem may exist even though the required source documents are on hand. The problem is that the documents may not be filed in a manner that facilitates post-auditing procedures. Under so-called "off-line" or "batch" accounting methods, source documents are accumulated into batches comprising economic processing groups. Information from the documents is transcribed to an input medium, such as punched cards or magnetic tape, and may then be sorted mechanically into some desired sequence. The documents, however, may not be sorted, but retained in random sequence. This problem is not new; it exists in present punched-card applications.

The problem may become more complex under so-called "in-line" or "continuous" accounting methods. Under this new approach, transactions will be processed in random sequence immediately after they occur. There will be no delay while enough transactions are accumulated to form an economic batch. The new concept of data processing is made possible through the recent development of random-access memory units that can store millions of characters. Data will flow into these systems in random order and on a continuous basis. Ledgers, files, and other internally-stored records will be up-dated immediately, and the status of each record will be available instantly to interested personnel through electronic interrogation. IBM's contributions to this field are the Ramac 305 and the Ramac 650. In announcing the machines, Thomas J. Watson, Jr., President of IBM, said "Ramac equipment will not only revolutionize punched-card accounting but also magnetic-tape accounting."

Returning to our problem, it is apparent that since transactions will be processed in random sequence as they occur, sorting of source

documents may become an extra manual operation that some programmers will consider unnecessary. The auditor must therefore insist that the source documents be arranged and filed in a manner that will accommodate his verification of the results of data processing.

There is another trend under way which may cause the auditor even more concern as to the validity of source data. This is the development of devices which may completely eliminate certain source documents. In the retail field, so-called "point of sale" recording devices could eliminate the traditional sales slips and cash-register tapes. In the industrial field, automatic production recorders may capture data, without reference to visible production tickets. Time cards may disappear if employees punch in by inserting identification plates in time clocks which automatically record the arrival data on tape or other coded media.

Fortunately (for auditors), little progress has been made in this direction to date. The trend is clear however. Development of devices which eliminate source documents will pose serious new problems in auditing techniques. New methods must be found of testing the validity of transactions that enter the data-processing pipeline. Equipment manufacturers will be encouraged to design their devices to produce source documents simultaneously with the capture of data in coded form. In some instances it may be necessary for the device or the computer to print the transactions for auditing purposes only. Perhaps the auditor will have to rely more heavily on observation in order to verify the authenticity of input media.

Correctness of Input Media

What control procedures can be applied to assure accurate transcription of data from source documents to the computer's input medium? Input media today consist of punched cards, paper tape, and magnetic tape. Behind these are such auxiliary machines as card-to-tape converters, punched-card reproducers and transceivers, Teletype receivers, tape-to-card converters, and many others. However, in the final analysis all input to electronic data-processing machines stems from an initial typing or keyboard operation. Accordingly, emphasis for control purposes must be placed on the typing or keyboard operations.

Control procedures for the typing or keyboard operations will undoubtedly resemble those now used in punched-card installations. These include manual review of document coding, key-verification of

card punching, comparison of source documents with proof listings, and balancing to independently determined batch totals. In one electronic system, magnetic tape can be coded directly with a typewriter. A separate typewriter is then used to verify the original coding.

The most effective way to assure accuracy is to eliminate unnecessary typing or keyboard operations, by mechanizing as much of the transcription work as possible. Many new devices are available for this purpose. Under the concept of integrated data processing, typewriters, adding machines, cash registers, and bookkeeping machines are equipped to prepare paper tapes or punched cards as a by-product of the preparation of an original document or record. The correctness of the coded media is established by inspecting the information typed on the document or record. Pre-coding of documents, such as the magnetic ink coding of checks as advocated by banks, will eliminate subsequent keyboard operations. Scanning devices will eliminate human transcription by reading information imprinted by Addressograph plates and otherwise. A more common example is the use of pre-punched cards which are prepared by reproducing verified master cards. All of these devices and techniques eliminate manual transcription and therefore increase the accuracy of computer input data.

Completeness of Input Data

One question remains regarding input. What controls are necessary to ensure processing of all transactions that should be processed? Again we find the answer in present controls for punched-card systems.

Source documents should be prepared by a department other than the data-processing department. They should be retained in the originating department and filed in a sequence that will facilitate identification with related records or documents prepared by the data-processing machines.

Batch totals or other control totals should be established by the originating department and subsequently traced to the data-processing results. Where such totals are inapplicable, documents or cards forwarded for processing should be controlled by pre-determined item counts or "hash" totals. For example, one company, which maintains a network of telephone lines for its IBM Transceivers, establishes card-counts for data transmitted to its EDP center. Cards automatically reproduced at the center are counted for agreement with the predetermined counts. Other control techniques are apparent. For exam-

ple, source documents should be pre-numbered and the numerical sequence accounted for by the originating department.

## PROCESSING

So far we have discussed various controls to establish the authenticity, correctness, and completeness of data entering an electronic system. In general, the control techniques are carry-overs from those found in punched-card systems and require only limited knowledge of electronic techniques on the part of an auditor. But the responsibility of the internal auditor does not stop short of the machine room. He must also evaluate controls within the EDP center. He must make certain that machine errors will be detected and that processing procedures produce the results intended.

Accuracy in electronic data processing is dependent upon two things: Machine reliability and adequacy of human planning and control. The latter includes programmed control and equipment maintenance policies.

### Machine Reliability

We can approach the matter of machine reliability with the comforting knowledge that electronic equipment as such is the most accurate tool yet developed for this purpose. The readability and storage ability of magnetic tape has now been verified by field usage. Internally, the machines have already amassed remarkable records of error-free performance.

Accuracy is really a matter of detecting errors. The extent of circuitry built into the equipment for this purpose varies from one make to another. In fact, the need for checking circuits is hotly debated by competing machine manufacturers because each additional circuit increases the cost of the system.

One type of an error-detection circuit is designed to check the data at various stages as it moves from one place to another within the equipment. It starts with parity-check bits placed on the magnetic tape by the recording mechanism. As the bits forming a coded character speed through the system they pass checking stations watching for missing bits. Error signals flash on the console unit when a character does not make sense to the machine. Since some errors are intermittent in nature, the machine, through programming, may reread the invalid character. If the error persists, the machine, again at the option of the programmer, will come to a sudden halt.

Some systems employ duplicate circuitry for arithmetic computations, whereby all calculations are automatically computed twice and compared. Other techniques used include those to detect invalid instructions, overflow conditions in an accumulator, and errors in tape writing, card punching, and printing.

The internal auditor's responsibility is to become familiar with the built-in controls of the particular system used in his company. He must do this in order to know what controls should be provided through programming.

Programmed Control

The various types of self-checking features that are built into the machines are important to the auditor. Of equal importance is the possibility of detecting errors by so-called "program checks."

A program check is included in the machine's internally stored instructions. For example, the machine may be told to verify the results of one operation before proceeding to the next. Opportunities for using these checks are virtually unlimited. In some instances, the checks are "free", in that additional machine time is either negligible or nil. In other instances, such as when the machine does not have enough storage capacity to store the checking instructions, verification may require an additional pass of the transactions through the machines. Thus, the limiting factor in programming a check is really a matter of economics — is the cost of the check proportionate to the losses which would result if the errors are not detected?

The internal auditor's responsibility is to determine that needed checks that can be justified economically are included in the machine programs. Obviously, all operations need not be verified, for a surprisingly large percentage of electronically produced accounting results can be substantiated by reference to independent data.

Here are some actual examples taken from electronic applications currently in use by some of the clients of our Firm:

A payroll program provides for proving the computation of the net pay of each employee. After the original computation is made, the deductions are added back and the new total must equal the original gross pay.

Another payroll program provides for a duplicate accumulation of daily earnings to develop weekly totals, for individual employees and for each department. The check is considered to be

fool-proof and has eliminated the manual recapitulation previously done by the payroll department.

One program tests the operating accuracy of the computer immediately after each important calculation. The machine computes a programmed arithmetic exercise which should produce a zero amount. If zero does not result, the arithmetical unit is not functioning properly and the machine is programmed to stop.

One payroll program provides for a comparison of computed piecework earnings with predetermined maximums. Checks of this type are known as reasonableness tests.

Several payroll programs verify withholding tax computations on an over-all basis, based upon an accumulation of individual earnings and exemptions. Over-all proofs of this type are reliable and economical.

Frequently it is expedient to use standard punched-card machines to check the work of an electronic machine. In a billing application, for example, a summary card containing computed invoice totals may be punched by the electronic machine. The invoices may be printed on a standard accounting machine from header cards and detail item cards, also punched by the electronic machine. The accounting machine could be wired to accumulate invoice totals and, using the well-known zero-balance method, determine that the totals agree with those previously punched into the summary card by the electronic machine.

In addition to verifying the accuracy of machine calculations, other types of program checks are usually necessary. Through the use of coded identification labels on each reel of magnetic tape, the machine can be programmed to determine that the manual chore of mounting the proper reel on the proper tape unit is performed correctly. Self-checking circuits may detect certain machine errors. However, unless properly programmed, the errors will not be printed out or otherwise brought to the operator's attention. During processing it may be necessary to transfer the contents of internal memory to a "check-point" tape so that if an error is subsequently detected the work can be backed up to that proven point.

Programmers frequently have a tendency to ignore the use of duplicate computations and similar program checks. They have a profound respect for the inherent accuracy of electronic hardware. They work feverishly just to develop a program that will do the required job. Accordingly, they consider certain program checks to be extra work

and of little or no value. Machine salesmen frequently share these views. These attitudes merely emphasize the need for a review of machine programs by the internal auditor.

As mentioned earlier, a console operator could, through some weakness in internal control or through collusion, introduce or modify both data and programs in an unauthorized manner. The auditor may suggest certain controls to minimize such activities. He might suggest that operating responsibility be fixed by requiring that all elapsed machine time be recorded in a control register showing the names of personnel responsible. He might suggest a rotation plan for the work of data-processing personnel. Under this plan, a console operator would have to permanently conceal an irregularity before turning the records over to his successor.

The auditor should also determine that provision is made for the reconstruction of data in the event of fire or accidental mutilation. Certain records on magnetic tape can be reconstructed from the introductory medium, such as punched cards. Here, the cards should be retained in a safe place until the possible need for reconstruction has expired. Other tape records, such as a perpetual inventory, cannot be reconstructed readily. In these cases, the auditor may suggest that the tapes be prepared in duplicate.

Maintenance Policies

In addition to built-in checking circuits and programmed verification, accuracy of processing depends upon the adequacy of maintenance activities.

When an electronic system is purchased, maintenance can be performed by customer personnel or by manufacturer's personnel on a contract basis. When the system is leased, maintenance by the manufacturer is usually included in the rental charge.

In one installation of a large-scale electronic data-processing system, the manufacturer has assigned a crew of six engineers to maintain the equipment. Four of these men work from 7:30 in the morning until 4:30 in the afternoon. The other two men work from 9:30 AM to 6:30 PM. One hour is devoted to preventive maintenance at the beginning of each day. Problems are fed into the system which test every possible machine command and the operating condition of tape drives, the arithmetical unit, core memory, auxiliary drum memory, and other units. A "high-low" voltage test is applied to detect marginal functioning of tubes and circuits. After the equipment is turned

over to the customer, the engineers subject available units of equipment to more comprehensive testing. Rigid schedules are followed which provide for periodic complete inspections of all components. Thus, some components are inspected monthly, others quarterly or annually, according to the manufacturer's specifications.

As installations become more prevalent, it is conceivable that a scarcity of competent engineers may force some manufacturers to curtail certain customer maintenance programs. When customers provide their own maintenance, it is not uncommon to find a wide deviation from the maintenance policies recommended by the manufacturer. For these reasons, the adequacy of maintenance practices should be investigated.

All of this is not to imply that an internal auditor must become and electrical engineer. However, it appears that his responsibilities might include: determining whether preventive maintenance schedules comply with manufacturer's recommendations; and determining whether adequate records of errors and machine down-time are kept and analyzed by reason.

## OUTPUT

Having considered some of the problems of input and processing, let us now turn our thoughts to the output of electronic data-processing machines.

Customary controls should be exercised over records, reports, and documents prepared by an electronic data-processing system. In a payroll application, for example, numerical accountability should be kept of payroll checks, responsibility for the supply of blank checks should be fixed, use of the signature plate should be regulated, and the distribution of all forms and records should be controlled.

The challenging problems, so far as output is concerned, involves information that is not printed, rather than what is printed.

Printed output is used externally by customers or other outside groups, or it is used internally. External output, such as invoices to customers, payroll checks, and shipping notices, may always be necessary in some printed form. But internal output, in the form of visible records, may, in some instances, be eliminated.

Management by exception, as applied to electronic data-processing systems, means that only those items requiring human action or

attention should be printed in report form – all other detail would remain in coded form in some storage medium or device. This is, indeed, a challenge to auditors, for we need, or at least we think we need, our familiar journals, intermediate works sheets, ledgers, detailed trial balances, and the like.

We must not retard the trend toward exception reporting simply because customary auditing procedures can not be applied. Management by exception is a useful technique. Through it, the electronic machines can relieve management and lesser personnel of many routine decision-making chores. Through it, the great potential usefulness of the flexible machines can be realized. We must criticize the technique only after we have found that it is impracticable effectively to audit the system by any method.

We may never reach the point where an auditor must serve as a constant watchdog, continuously assigned to the observation of input, processing, and output of a completely automatic system. However, we must determine our auditing requirements for each new application in this rapidly changing field of data processing.

Under EDP, the files and permanent records of several departments may be consolidated. For example, a consolidated stock record may be stored on magnetic tape or in a large-capacity internal storage device. Processing of transactions would, in a single pass, up-date the records of, say, production control, purchasing, inventory control, and cost accounting. If the transactions are normal and the adjusted records require no human attention, the program might not provide for a print out of an audit trail. In such cases, the auditor may be justified in insisting upon the printing of a chronological record showing the manner in which the transactions are processed. After all, auditing is necessary and must be accommodated at times even though preparation of audit media requires additional machine time.

In lieu of a continuous printing of transactions, the auditor may find a substitute procedure. He may request that the audit trail be written only on magnetic tape. The reels of tape could be filed for a reasonable period of time. The auditor could then select certain reels and have the information thereon printed for test-checking purposes. Or, the auditor may devise a set of representative transactions for his testing purposes. The transactions could be either real or fictitious, with predetermined processing results. The auditor could then run these transactions through the electronic machines and compare com-

puted results with the known results. This would enable the auditor to pass judgment on the effectiveness of the machine's stored program.

In some instances, the policy of reporting exceptions only may be helpful to auditors, rather than a problem. Through statistical sampling the machine may select items for his tests. The machine could then test these items for him, leaving a visible record for the bulk of the transactions in comparatively short order. He could then turn his attention to the exceptional items which are printed out and which deserve more of the auditor's time in the first place.

## OTHER IMPLICATIONS

The auditor's review of the internal control and auditing implications of an electronic application preferably should be done several months before the new system is placed into actual operation. If his review discloses need for additional controls, the required programming or other changes can be made more easily at this stage.

During his review, the auditor should devise a check-list for evaluating subsequent applications. He should revise his former audit program to give effect to changes caused by the electronic system. He may develop scientific sampling techniques and other means of utilizing the machine for his auditing purposes. He should arrange for special print-outs that will be required for audit purposes at a later date.

Conversion to electronic data processing will necessitate careful planning on the part of the auditor. For example, the auditor may wish to confirm customers' accounts receivable as of some future date. His preliminary review may disclose that the system does not provide for printing periodic trial balances. He must then allow ample time for preparation of a program which would cause the machine to print out the trial balances as of the specified date. The trial balance will be available only at that date because the balances will change when succeeding transactions are processed.

## SUMMARY

How much do we really have to know about electronic data processing to do an effective job of auditing? This was our original question. Perhaps the answer can be developed by summarizing the points previously mentioned.

As to the broader aspects of internal control, it appears that the

auditor should, with no specific training in EDP, be able to determine the adequacy of cross-checks between departments. He can determine that the basic functions of authorizing, recording, and asset-custodianship are segregated.

On the other hand, specific training in electronic data processing usually will be necessary if the auditor is to determine whether a proper segregation of duties exists within the data-processing department. He must know the mechanics of altering data and machine instructions if he is to determine the opportunities for irregularity afforded to the operators, individually or through collusion.

Without additional training, the auditor should be able to establish the authenticity of source documents and to determine that they are filed in a manner that facilitates auditing. However, in the event certain documents are discontinued as a result of automation, knowledge of machine capabilities will be very helpful to the auditor. He could then suggest practical means for providing an adequate audit trail.

Without additional training, the auditor should also be able to appraise the control of typing and other keyboard operations. The control methods are designed to assure accuracy of input media and are the same as those now used in punched-card systems. Elimination of repetitive typing through integrated data-processing techniques merely simplifies this control area.

Similarly, the auditor should, with no additional training, be able to appraise the controls to ensure processing of all valid transactions. Batch-totals, card-counts, hash-totals, prenumbering, and other techniques of documentary control are familiar procedures that will be continued.

However, the auditor very definitely will need specific training in order to determine that built-in error-detection devices are properly utilized.

Similarly, the auditor must understand the rudiments of programming if he is to determine which phases of an application should and can be verified through use of program checks.

Specific knowledge will also be necessary in order for the auditor to determine whether provision is made for reconstructing data in the event of fire or mutilation.

The auditor's review of maintenance policies will also require basic machine training.

Technical knowledge will most certainly be needed when journals,

ledgers, and other internal records give way to invisibly coded tapes or memory devices within a machine. We must develop new auditing techniques if we are to keep pace with the new processing techniques.

## CONCLUSION

Many traditional auditing procedures will not be changed by the introduction of electronic data-processing machines. Most of our procedures will continue to be performed independently of machine operations, by verifying processing results through reference to source document or by other customary practices. However, some auditing techniques will change, and some of them may change drastically.

Audit trails and control requirements are just as essential under electronic data processing as they are under any other system. Efficiency of data processing is a desirable goal; but this goal must not be realized at a sacrifice of necessary controls and auditability.

The internal auditor, in many instances, will be the logical person to appraise the control and auditing aspects of electronic machine applications. To do this he must first prepare himself. Preparation will require considerable effort, but it need not be viewed as a Herculean project. Most of the mysteries associated with the gigantic machines will be dispelled in the first programming course.